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PORT DEVELOPMENT IN SUPPORTING CONNECTIVITY SYSTEM OF ARCHIPELAGO REGION

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ABSTRACT

The development of port infrastructure and connectivity between ports could influence the economic improvement of natural resources potency related to the population prosperity. Therefore, port development is needed -so it could anticipate the enhancement of loading and unloading of goods and services. The research site was located at Malawi Port in Konawe Utara, Southeast Sulawesi.

Combination of qualitative and quantitative research method was used as research approach used in this study. The Proportion of the analysis was still dominant using a qualitative approach, supported by a quantitative approach. Data obtained by using both primary and secondary were directly analyzed in the interpretative and quantitative way by referring to references. The research design was conducted using survey method and direct observation to the research site to obtain accurate data and information.

The result of the study showed that Malawi Port development needed to be done by the increase of dock length to reach the depth so that non-operated or non-directed ships could be directly docked at the harbor. Inter-island connectivity system has not been supported by supporting infrastructure so the port operational has not been effective and efficient for the loading and unloading of goods and passengers.

***KEYWORDS:** Development, Operational, Port & Connectivity*

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Original Article

INTRODUCTION

The development of transportation is directed to bridge the gap between regions and enhance equitable distribution of development outcomes. Inter-regional transportation will raise opportunities for trading; reducing price differences; be increasing the mobility of goods, services, and labors in order to reduce the concentration of skills and abilities in some areas. Thus, encouraging the creation of opportunities for development, opening isolation, increasing mobility and social contact between the population could maintain activities and facilitate access to the use of technology as well as improving social aspects. The process is capable to support the economy aspect of the local citizen and increase local revenue.

Sea transportation plays an important role in the world of trading because it has high economic values such as heavy loads of carrying capacity and relatively low cost. Ports are created as anodes of goods cargo shifting where ships can dock, lean, load, unload and continue to other areas of trading in order to support trading and cargo traffic (Kramadibrata, 1985). Port is important, especially for sea transportation. The required mileage will be faster -with this transportation, especially for the economic development of an area where the center of consumer goods

can be marketed quickly and smoothly. In addition, ports have a positive impact on the development of an isolated area based on the economic field, especially in waters areas where accessibility by land is difficult to do.

Port as a link to the transportation system acts as a connecting system in an economy. The classical principle of economics is to sacrifice as little as possible to get as much profit as possible. In terms of cost and geographical location of Indonesia, ports are related to the classical principles of economy, compared to the air transportation that still has expensive cost. In this case, port acts as a place of ships loading and unloading of goods that are intended to facilitate the movement of goods and services from sea transportation to land transportation and vice versa.

Port as a link can enable the goods (commodities) to be generated by the area behind the harbor (hinterland) and marketed outside the region so that the goods can have added value (Added Value) related to the time and place where economic activities take place. If economic activities can take place while maintaining economic principles, then, in turn, there will be regional development in the area behind the harbor (hinterland). Hinterland commodities can be marketed out of the region, both between regions in the country and abroad because of the port. Then, there is a smooth flow of goods and services in trading.

Besides link, the port also is used as a gate (gateway). As gateway, port helps operating regional, national and international trading. In order to fulfill the demand, a port function must be optimized for both physical (facilities and infrastructure) and non-physical (service or service). The function of the port as an industry entity is very important in development. One of the factors that can affect is the availability of transportation services. Transportation is an important factor that needs to be considered because the transportation activities, including transporting and moving to the destination place, requires a very expensive cost. Therefore, it is required an effective and efficient transportation system.

The abundant natural resources will be meaningless if there is no transportation service that brings the goods to the consumers. In addition, the raw material or energy produced by the mining will have no value if there is no transportation that can facilitate the raw material to be processed to the industrial location to create finished goods. In this case, the increase of trading requires port function as an industry entity to increase the growth of hinterland economy which can turn to develop the region. The development and growth of a port are determined by the extent of its service area since it plays a role in determining the type of commoditiesquantity or passengers traveling through the port.

LITERATURE REVIEW

Port

According to Gurning and Budiyanto (2007), the port is a place consisting of land and water and surrounding areas with certain limits as a place of Government activities and service activities. Besides, the port is where the ship is leaned, anchored, lifted up and down passengers and/or loading and unloading of goods equipped with shipping safety facilities and port supporting activities as well as canal and inter-modal transportation. Meanwhile, Suranto (2004), said that port is a place consisting of land and surrounding waters with certain limits as a place of government activity and economic activity which is used as a place of ship leaning, anchored, up and down passengers, and/or loading and unloading of goods which is equipped with a shipping safety facilities and supporting port activities and as well as a place inter-modal transportation. The public port is a port that is organized for the benefits of public services.

Meanwhile, Jinca (2011) said that the ports are a watershed protected against storms, waves, and currents. So it can be said that the ships can hold movement, lean back, throw anchor in such a way that loading and unloading of goods

and passenger movements can be done well. The main function of port is displacement function of the industry in terms of port entrepreneurs, completing the facilities for the activities of ships at the port such as the shipping channel for in and out of the ships from and to the port, mooring equipment, loading and unloading activities at the dock, checking goods, warehousing, and provision of local transport links in the port area.

Soemantri (2003) said that ports can play a role in stimulating the growth of economic, commercial and industrial activities from their spheres of influence but they do not create such activities. They only serve to grow and develop these activities such as activities in the increasing role of ports from just as a shipping place to the center of economic activity. Bintarto (1983) said that, in terms of regional importance, port area has an economic meaning that the port has import and export function of other economic activities that are interconnected by cause and effect. Along with activities at the port, the economic benefits can be seen by the opening of many job fields for surrounding community as well as in all areas of activities. Human labor will be much needed at the port such as laborers as porters, port traffic controllers, and janitor port.

The Role of Ports in Port Infrastructure Development

Infrastructure development is an integral part of national development. Infrastructure is the driving force of economic growth. Transportation sector activity is the backbone of the distribution pattern of both goods and passengers. An Other infrastructure such as electricity and telecommunications related to the nation's modernization and its supply is one of the most important aspects to increase the productivity of the production sector. The availability of housing and settlements, including drinking water and sanitation so as widely and equitably sustainable management of water resources, will determine the level of community welfare. In this context, future approaches to the development of region-based infrastructure are increasingly important to note and consider as the major development. Experience shows that transportation infrastructure plays a major role to open up the isolation of the region, as well as the availability of irrigation. The system is a prerequisite for the successful development of agriculture and other sectors.

Port infrastructure has a very strong linkage to economic growth, social welfare and even social-politics as indicated that regions with better port infrastructure will have welfare levels with good economic growth. Thus, the development of port infrastructure is one of the main factors of economic growth or the development of a region. Dekker et. al. (2003) emphasized that infrastructure development through capacity expansion will have a positive impact on national and regional economic development. The development of the infrastructure must be acceptable to the community with various considerations such as environmental effects, urban planning, and social-economic aspects although the cost of development becomes more expensive (Dekker et al (2003).

Infrastructure in a very larger context refers not only to the number of containers, cranes, tug areas and terminal areas, but also to the quality of the cranes, the quality and effectiveness of information systems, the capability of integration of intermodal transport (road and cart) and port management (Tongzon and Ganesalingan, 1994). If the volume of cargo-handling capacity of the port is big and heavy, it results in congestion on the port and inefficiency. The case may harm port users. Then, the limited access to information on ship arrival will bring effect to the bad information system. It will slow down the documentation process and slow down the port function itself. Without the availability of inter-modal links, ship users cannot easily move their cargo from ports to ports. It can create stagnation, delays and higher costs of operating the sea transportation.

Wibowo, et al (1999) emphasized that regional development is an effort to develop and improve the interdependence and interaction relationship between economic aspect, human or community system, environment and natural resources. A study conducted by Ahmed and Hossain (1990) indicated that areas of developed transport infrastructure have a significant impact on villages with undeveloped transportation infrastructure. The results of research conducted by World Bank (1994) showed that the development of road infrastructure has increased the social activities of the community, which then increased economic activity, communication and eventually could create new jobs for the community.

Infrastructure development is one of the supporting factors of the economic development in a country. Bhattacharyay (2008) had identified the important role of infrastructure in regional development. It is being a fundamental factor that can drive the change in the economic field in various sectors both locally and internationally. Infrastructure development influence greater access to input for economic growth such as natural resources, technology, and knowledge. It can also improve social-economic and environmental conditions. Infrastructure development is also able to increase physical connectivity both domestically and between countries so that it can facilitate the movement of goods and service as well.

The fact regarding infrastructure development was reinforced by Kessedes and Ingram (1994) which mentioned that there are several infrastructure benefits to the economy including (1) reducing production costs; (2) expanding employment and consumption opportunities due to the opening of isolated areas; and (3) maintaining macroeconomic stability through investment in infrastructure to increase labor and consumer purchasing power to goods and services.

States and regions will develop if there is inter-regional trading activity from one region to another region so that there will be an increase in development investment and the increase of economic activity due to trading activity. Regional incomes earned from exports will result in the development of local activities, capital and labor migration, external benefits and further development of the region (Damapolii, 2008). Based on the certain principle, the relationship of development activities by humans in the sea cannot be separated with development activities on the beach even on land entirely. In the context of spatial economy, it can be seen that the sea, coast and even coastal cities are economically integrated. Even port sector will depend not only on maritime territory or space as a vehicle or sea transportation but it is also dependent on the city and region systems that support it. This can happen since the port's function depends on products exported and imported as well as humans who will travel from and to a region.

Connectivity System

Jinca (2011) In the archipelago region, strengthening the connectivity system is needed to make the inside island and inter-island connections run smoothly in supporting the development of a region's economy. Connectivity in Sislognas is Local Integrated, Globally Connected and has 3 levels of integrated connectivity: Local Connectivity (Intra Island), National Connectivity (Inter Island) and Global Connectivity (International) as shown. In the archipelago region, connectivity scenarios are expected to open up isolated areas linked to economic centers in order to aim at reducing price and service disparities, increasing competitiveness and accelerating poverty alleviation. The aims can ultimately increase social and economic accessibility. The role of ports in the connectivity system is the point of transfer of modes between sea transport and land/road transportation as shown in Figure 1.

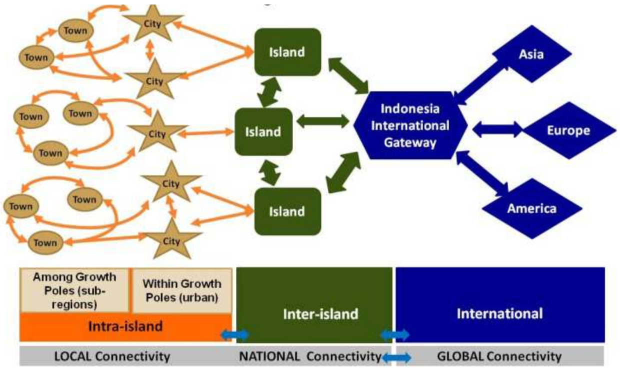

Figure 1: Connectivity Level

Port as the main element in sea transportation system is a supporting factor of economic activities, providing services for mobility of people and goods and being a catalyst for economic growth. Ports can play a driving role in remote areas of development as it is known to be pioneer transportation to open isolated areas, increase trade, mobilize the population, reduce regional disparities and realize regional stability. The connectivity or node chain has 4 functions as (composition, connection, interchange, decomposition) in intermodal transport (Rodrigue and Comtois) as shown in Figure 2.

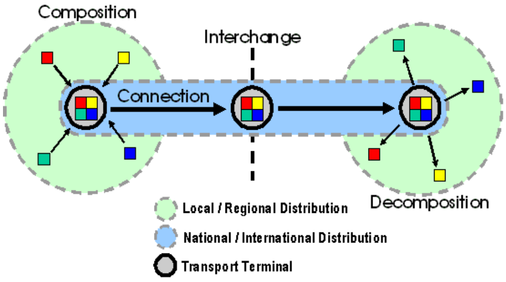

Figure 2: Intermodal Transportation Chain

An advance in transportation technology is being a follow up of economic and trading fields, as well as the reverse. Transportation has the role of expanding scope and sequence of the goods and services distribution, supporting the efficient distribution of industrial logistics and the specialization of production activities. Transportation also creates a concentration of production activities in one place and produces"Economics of Scale" and "Agglomeration Economics"in the logistics system as shown in Figure 3.

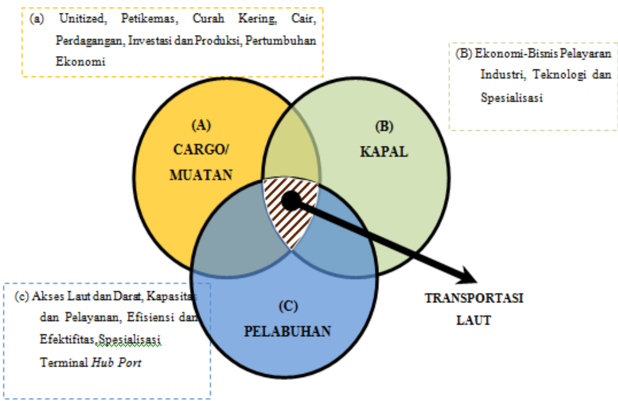

Figure 3: Sea Transportation System

As an archipelago country, Indonesia has an area of dispersion of hinterland, connected by road transportation to port, sea transport system (seaport, shipping, and potency of goods mobility) as shown in Figure 4 has a very important function. Seaport as the point of distribution service by sea and as the center of sea transportation activities has provided space for industry and supported building construction.

Sea transportation is more efficient for transporting large quantities of goods since the speed is proper and the cost of transportation per ton of miles is relatively low. Sea transportation is very useful for long-haul transportation in archipelago regions.

Port is an area that has the properties (facilities and infrastructure) in supporting operational activities. The infrastructure is a facility that must exist in a port to support the operations or port business. Port infrastructure or facility consists of basic facilities (facilities) and supporting facilities (infrastructure). This division is based on the interests of the port itself.

In a comprehensive way, the role of the port is not only from its existence and future development. The existence of port is related to the planning and management aspect in supporting the development of regency, between regions/islands/harbors so that there is an interaction between development resources, such as community, natural resources (sector), funding, technology, and other development resources.

Ports play a very important role and function in trading of regional, national and international development, including gateway in and out of goods and passengers to and from a region, where the port is located. The role and function of the port include various aspects, namely:

- The availability of port facilities and infrastructures that serve the loading and unloading activities of ship goods and visits, related to the rear connected areas by land transportation, investment, technology, management and service quality.
- The linkage of ports on one island to ports on another island (national and international), related to the surrounding harbors the origin and destination of the mobility of goods.
- The linkage of a port with the social, economic and environmental aspects of port development to the surrounding area.

METHOD

Research Approach

Research approach used is a combination of qualitative and quantitative research. A proportion of analysis is predominantly using a qualitative approach, supported by a quantitative approach. Data obtained both primary and secondary are directly analyzed using interpretative and quantitative method along within existing reference (literature).

Research Site

The research site is Malawi Port which is located in North Konawe, Southeast Sulawesi. Malawi Port can be reached by road transportation using two wheels and four wheels vehicles or using sea transportation. The site is presented on the Location Orientation map that is shown in Figure 4.

Figure 4: Research Sites Map

Data Collection Technique

This study was designed using the descriptive method with qualitative and quantitative analysis. Data design and information are collected through observation, interviews, and documentation to obtain the facts of tendencies and seek actual information to find out on how capacity readiness and port facilities can support the accessibility and mobility of leading commodities at NorthKonawe.

Ocean Tide Method

Ocean tide observation data is needed to determine design of water level, harbor dimension, dock elevation and for coastal hydraulic analysis. Ocean tide states will affect the location of breaking waves. Ocean tide data is obtained from 24 hours observation within an interval on every one hour for 15 days in a row. From the Ocean tide measurement data, some water level elevation such as MHWL, MSL, and MLWLcan be obtained.

Field Measurement Method

Ocean tide observation is done by observing sea level fluctuations for 7 days in a row within one-hour interval. Ocean tide observation is done by installing peilschaal in the sea. Peilschaal used is peilschaal with a 1 cm scale interval. Peilschaal is placed in an easily observable location, always submerged in water (peilschaal base is below the lowest tide level) and firmly mounted so it is not easy to change position due to natural conditions. The peilschaal interval should be longer than the maximum possible ocean tide limits. If a low tide happens, the peilschaal zero point is not submerged (dry). Additional peilschaal installation is performed so that at that time the water level elevation still can be read.

Topology Data Method

Topology measurement data is required to create situation images, cross-section, and long-section. The creation of a certain picture (topographic map) is required to obtain the actual field situation due to plan the coastal protection building. This work includes benchmarking, complementary azimuth markings, skeletal polygon measurements so as binding, flat plate measurements, cross-section measurements, and elongated measurements.

- **Benchmark Assembly**

Benchmarks are installed at 1.5 km intervals of 40 x 40 x 100 cm and planted as deep as 80 cm, following a polygon path and installed at least 100 meters from the coastline. The wooden stakes for profiles are painted red. He wooden stakes has 5 x 5 x 40 cm at a size, planted as deep as 30 cm and 10 cm appear above ground level. Installation of the wooden stakes has done in every 50 m on a straight coastal area except in the curved bend area at the minimum

distance of 25 m.

- **Woods and Concrete Stakes Search and Assembly**

The search is intended to determine the placement points of wooden stakes at 50 m intervals. The installation of the stakes is meant as the measurement points. It is made in the form of the installation using wooden stakes and concrete blocks (BM/CP).

- **Polygon Measurement**

The polygon measurement consists of angle and length measurements that will be used to determine coordinate points based on one reference plane. In this case, the reference field used is the Universal Transfer Mercator (UTM) coordinate. The polygon measurement form for this work is the measurement of open polygons with azimuth control. The length of polygon measurement conducted on this work is 4 km.

- **Sun Azimuth Measurement**

The purpose of solar azimuth observation is to determine the azimuth of a polygon measurement framework using magnetic azimuth. Besides, the observation of the solar azimuth is also conducted by using the method of sun height measurement.

- **Flat Plate Measurement**

The purpose of measurement in flat plates is to determine the height difference of the points measured by using the Nivo plane. From this height difference, it will be used to determine the elevation based on a particular reference plane, in this case, the mean sea level (MSL). To be able to get along with polygon measurements, the flat plate measurement system used in this study is an open flat plate. On the measurement of the open flat plane, the measurement is done by going back method or double standing method since only one of the end is known to determine the elevation.

- **Cross-Section Measurement**
  - **Bathymetry Data**

Bathymetry measurement data is needed to create bathymetry maps. Bathymetry maps are required to know the position and the depth of the sea around the site. This map is used to determine the wave states at the location. Measurements are carried out to a distance of 1.0 km from the coastline.

  - **Wave Data**

Wave data is obtained from wave forecasting based on the wind. The result will be inferred to be wave direction, wave frequency and wave period from the plane of the wave based on these winds.

  - **Sea Current Data**

Sea current measurements are carried out to determine the direction and velocity of sea currents that will be used in determining a hydrodynamic behavior of waters such as dominant sediment directions.

  - **Sediment Data**

Sediment collection is used to determine the dominant sediment transport in coastal areas. Beach sediments can be derived from the erosion of the shoreline itself, the land carried by the river and the deep ocean that flows into the coastal

areas. The study uses sample sampling bottles equipped with ballast valves for the sampling of sedimentary kites. Basic sediment collection uses one unit of Bottom Grabber tool.

- **Wind Data**

Wind data is required for forecasting and wave periods. Wind data collection has also taken using secondary data -in addition to its own observations. Wind data used as reference material is taken from Meteorological Station.

- **Social-Economy Data**

Implementation of this social-economic data is taken by using certain jobs taken, including data on the state of social life and the economic condition of the surrounding area, as well as its impact on the area.

Method of data collection used in this field study is socialization within the community and the surrounding population. Some of the secondary data used are North Konawe maps in Figures 2017 which is obtained from the Central Bureau of Statistics of the North Konawe.

RESULTS AND DISCUSSIONS

Port Administrative Location

The location of Molawe Portis in Malawi Village, Malawi District, North Konawe, as shown in Figure 7. Based on results of the latest study, Malawi Port location plan has existing ports built there such as ports, trestles, docks, Syahbandar offices, warehouses, terminals, parking lots, piling grounds, guard posts and access roads in the area and others. The area of Malawi Port on land is +23349.93 m^2 as shown in Figure 5.

Figure 5: Map of Malawi Port Plan

Port Coordinate

Malawi Port is located in Lasolo Bay at coordinates 03^o 36'6.76 " of South Latitude and 122^o 12' 1.20" of East Longitude. The coordinate system used is UTM coordinate within WGS 51 of the ellipsoid. Coordinate North-East reference used is BM 0 and it is observed by using GPS with static tracking method. Coordinates are obtained by simple alignment of a single point. Furthermore, the dots are propagated to other BM and all polygon webs on land topography. Coordinate systems on topographic and bathymetry maps are used in UTM systems with WGS 51 of an ellipsoid, North-East coordinates taken from instantaneous GPS observations.

Port Activity

The Port of Malawi is classified as Regional Port. Regional Port is Primary Feeder Port which serves the activities and the transfer of national sea freight in a relatively small quantity as well as the feeder from the main port. Activities served by port in general, is loading and unloading of people's shipping such as domestic and foreign goods/animals and passengers. Based on the development of Malawi Port, the type of ships served are the general cargo ships within 1500 DWT. The plan of ships criteria that will be served in the port are:

- Tonnes : 1500 DWT
- Length : 81,000 m
- Breadth : 12,4 m
- Draft : 4,90 m
- Speed in ship docked : 0,2 m/s

Regional State in Around Port

Malawi District is classified as a coastal area with flat topography and hilly. Malawi sub-district has extensive water area and several islands such as Bawulu Island, SisihIsland, BuruhIsland and Meong Island along with wealth potential of the location based on the plan. The ship's plan characteristic is according to (Triatmodjo, 2010) to support community prosperity.

The sea at Malawi has a beautiful panorama. Therefore, the waters in Malawi District are very suitable for the development of marine tourism.

Access from the sub-district capital to all villages in the Molawe sub-district is quite easy since all villages can be reached by twowheels vehicles, except for villages on the island such as Tapunggaya. Thus, they must be reached by outboard motor boats though in the sea wavelength is high enough during April until September.

The population of Malawi in 2017 is 6,008 inhabitants, consisting of 3,164 male and 2,844 female residents. It can be said that the number is increasing at 1.03 percent from the previous year. There are 1,215 households in Malawi. Each household has an average number of members within 5 people. All of residents in Malawi are Indonesian citizens (WNI). The population gender ratio of Malawi is 111.25. It means that out of every 100 female populations there are about 111 male population. Based on the data existed, the population is almost equal.

Dry land area in Molawe in 2017 is 23,411 Ha, including 4% of dry land used for the yard/building, 61% of tegal/garden, 32% of huma/field and 3% of smallholding garden. Land used in Molawe is classified into 12 categories namely; rice fields, yard/land for buildings and surrounding, tegal/garden, huma/field, prairie land, unplanted lands, ponds/pools, uncultivated temporary lands, timber plants, state forest lands, estate lands and other lands.

Access Road State from and to Port

The condition of an access road to Malawi Port due to the arterial road has been using asphalt. Meanwhile, the road leading to the port has not been on the asphalt. This state has reflected in the results of transportation disruption. The condition of the access road to the port shown in Figure 6.

Figure 6: Access Road of Port

Bathymetry and Topography

Topographic measurements are tied to ground elevation of BM, determined by an average value of sea level or MSL based on ocean tide (tidal) data as shown in Figure 8. BM is directly tied to tidal palms were BM0 with elevations MSL +1,369 m and LWS +2,659 m are obtained. Then, the elevation is tied to all existing BMs. The coordinate value of BM is shown in Table 2.

Table 2: The Coordinate Value of BM

Benchmark (BM)	Koordinat (M)		
	E	N	Z
BM 0	411266,000	9600692,000	+2,659 LWS
BM 1	411225,738	9600656,782	+2,476 LWS
BM2	411290,628	9600723,374	+2,673 LWS
BM3	411325,058	9600675,008	+2,773 LWS
BM4	411104,283	9600839,933	+2,198 LWS

The same is true for bathymetry survey at the site plan where this data is needed to determine position and depth of the sea around the Malawi Port plan site. This map can also be used to obtain an overview of wave states in the plan location. Measurements were made to the sea depth of approximately -14 m below the water level plan (LWS). In the making of a map combination, situation maps and bathymetry maps are made on a scale of 1:2000. to be able to aim the planning purposes, implementation of bathymetry measurements is performed simultaneously within topographic measurements of the land using a Total Station (Top Cone) measuring instrument. The process has been done in such a way that the contours of the seabed are located around the planned site. The combined topographic maps of land and bathymetry are shown in Figure 7.

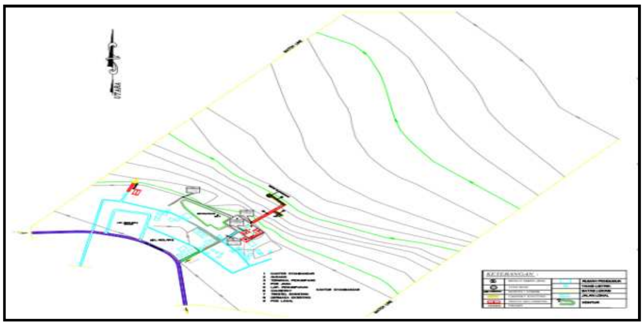

Figure 7: Bathymetry and Topography of Port Molawe Location Plan

Ocean Tide State

Ocean tide state analysis (tidal analysis) is conducted to determine sea level fluctuations and the water level of the plan related to port planning, as well as to know the type of tidal events that occur and predict the fluctuation of the water level. Tidal observation data is not significant enough related to the time of execution which of course is relatively not yet describe the maximum and minimum conditions that occur during the year of the planned location since there is no significant length of time in planning (±1 month).

From the observation, it can also be seen that tidal data obtained from the Maritime Station of Kendari, which is the date of January to December of 2016, data needed to plan the development of Malawi Port has been taken from the highest tidal data in the year 2016 within 31 days (± 1 month) which is data in October. Furthermore, the ups and downs in the Malawi Port location plan follow the trend of tidal data at Kendari Maritime Station, considering that this data will be used for technical planning needs of dock, trestle peaks and harbor pools, as well as the difference between HWS and LWS observations at relative project sites based on data in questions. The tidal data is made in curve form of the graphic as shown in Figure 8.

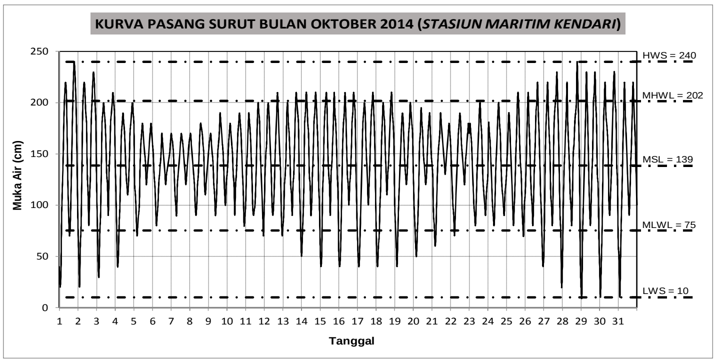

Figure 8: Graphic Data of Ocean Tide Observation at Location Plan

From the graph in Figure 8, it can determine the value of High Water Spring (HWS), Mean High Water Level (MHWL), Mean Sea Level (MSL), Mean Low Water Level (MLWL) and Low Water Spring (LWS). The results of the calculation of HWS, MHWL, MSL, MLWL and LWS values from the graph above are 240 cm, 202 cm, 139 cm, 75 cm and 10 cm.

It can be seen that the difference between HWS and MSL is 101 cm. The difference between MSL and LWS is 129 cm. For the needs of topography and bathymetry map depiction, the elevation of the water level results from the tidal data shall be further attached to the fixed point or Bench Mark (BM), in this case, BM0.

Wave and Wind Wave State

The change of season due to direction and wind speed is influenced by seasonal changes. In the dry season, high-speed winds blow from south to southeast. In the rainy season, the wind becomes weaker and blows from the southwest to the northwest. The annual distribution of wind in the plan location reflected in wind rose is shown in Figure 9.

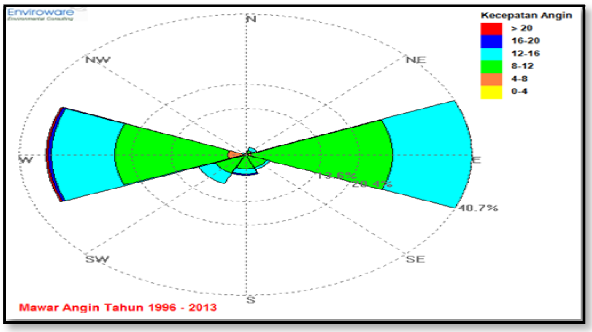

Figure 9: Wind Rose Data

Wave

Waves are a major factor in the determination of the port planning layout and framework. The frequent and important waves in the sea are generated by the wind. The waves are generated by the wind due to the transfer of energy from the wind to the surface of the sea due to fluctuations in air pressure at sea level. This generation process occurs in an area called the wave generation (wind wave generating area). Wind pressure will cause a tension at sea level so that the surface of the original seawater will be disturbed and be a small ripple. If the wind speed grows stronger, then the ripple gets bigger and will eventually form the wave. The longer and stronger the wind blows, the larger the waves are formed. The height and period of the waves formed depend on: wind speed, the length of wind and the generation of waves (fetch). Waves can generate energy to form a beach, causing currents and sediment transport in the direction perpendicular to and along the coast. Waves also cause forces, acting on the building. If the east is 3791,130 m, then it will be determined that the south-east is 4562,757 m. The results of the effective fetch length calculation are shown in Figure 10.

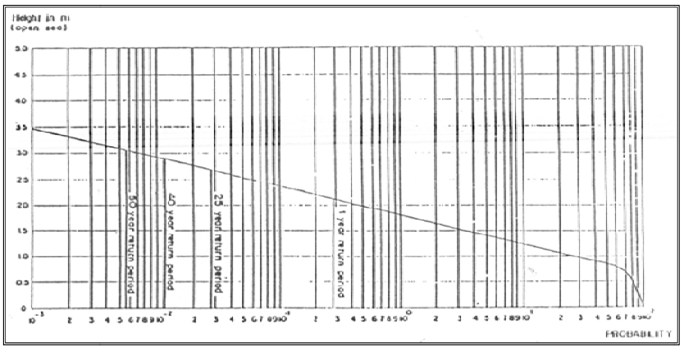

Figure 10: Sea Wave Height Distribution

Ship Specification

The largest ship planned to be served in MolawePort is the general cargo vessel of 1500 DWT. In relation to the plan of ship criteria to be served at the location of the plan, The characteristics of the ships that will be served at the port as planned are stated by (Triatmodjo, 2010) as follows:

- Tonnes : 1500 DWT
- Length : 81,000 m
- Breadth : 12,4 m
- Draft : 4,90 m
- Speed in ship docked : 0,2 m/s

Dock Specification

A dock is a port facility used to harbor and moor the ships in order to perform various activities at the port, such as loading, unloading, refueling and waiting for the pier being full. The dock dimension is based on the size of the tethered ships, the number of ships and the time it takes to unload.

Port planning is developed due to the shipping weight that is around 1500 DWT. The ship length varies, ranged from 81 m and more so that the length of the dock required at least 80% of ship length or around 64 m. Based on the calculation, the dock planning will take70 m long. The length of the dock planning is presented in Figure 5.1 and it has been related to the results of this calculation. However, the length of the dock is intended to the length of one ship dock. If more than one vessel is docked, then the other ships anchored are waiting as shown in Figure 11.

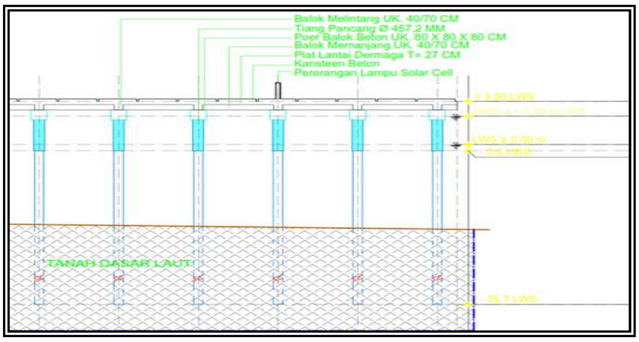

Figure 11: Cross-Section of Dock Plan Dermaga and Trestle

Furthermore, in determining the elevation of the peil floor plan of the Malawi Port development, it will be relatively higher than the existing dock elevation. Based on the topographic and bathymetry maps in the planned location, the HWS value is 2,300 LWS. The peil elevation of the dock floor is determined by the following calculation:

Elevating dock floor= 1,2m + (HWS =2,1m LWS) + (SF = 0,2)= 3,500 m LWS

Safety Factor (SF) in the dock planning, trestle degradation and the impact of sea level change due to global warming, where the SF value is taken at 0.2 m. Based on the calculation, the peil dock floor elevation of Malawi Port development plan is 3,500m LWS. The value of peel elevation difference of pier floor to BM is -0.841m from BM0. The elevation of the whole pier building plan is presented in Figure 13. For additional information, the existing port dock depth position is 4.5 m - 5 m.

Depth of Pool and Port Flow

The planning of swivel pool area, the layout of an area used to change the standard minimum of ship direction ships is a circle with 1.5 times of radius based on total ship length (L_{oa}) of the largest ship. It will be used when the velocity of the ship is performed with the help of anchors or tugs. The minimum swivel pool is the area of the circle with the radius equal to the total length of the ship (L_{oa}). Minimum swivel pool area at Malawi Port development plan location are as follows:

$A_{swivel\ pool}$ = $\pi .\ r^2 \rightarrow$ where ($r = 1{,}5.\ L_{oa} = 121{,}5$ m $\approx$ 122m)

= π.1222 = 46759.465 m2

= 46760 m^2

According to the various references, the depth of the harbor pool is 1.1 times the draft of the vessel at the full load below the planned water level. For the ship's characteristic of the Malawi Port development plan (1500 DWT), the minimum port pool depth is as follows:

$$H_{kolam} = 1{,}1.\ \text{Draft} \rightarrow \text{dimana}(\text{Draft} = 4{,}9\ \text{m})$$

$$= 1{,}1.\ 4{,}9 = 5{,}390 \approx 5{,}5\text{m LWS}$$

From the bathymetry map, the location of the plan (Figure 7) shows that the depth of the existing harbor pool is greater than the required parameter so that it is concluded that the depth and the width of the harbor pool location based on the plan has met the requirements. The complete port pool layout is shown in Figure 12.

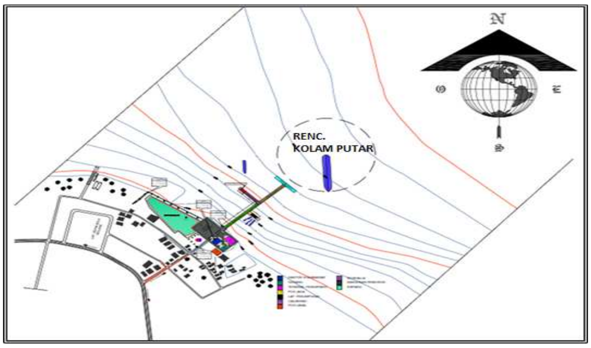

Figure 12: Swivel Pool Plan

To be able to reduce the difficulty of the voyage, the trajectory of the cruise line is an expected to be a straight line as well. Factors that can influence the selection of traces are seafloor conditions, shipping conditions (wind, currents, waves) and auxiliary equipment (lights, radar). The flow path is determined by local states and conditions. The type of ships that will be used it in this case are ships with 1500 DWT of weight as the basic planning.

Connectivity System

To increase the development, a region requires a new breakthrough in order to explore the potential of its territory. The breakthrough of the Sea Toll concept through the development of ports to connect the archipelago region - becomes an important thing to be realized.

Sea Toll concept is expected to create an efficient distribution system of goods and services. By using large capacity ships, the mobility of goods and services will be efficient. In addition, the certainty of shipping schedules will also fix the cost of logistics.

Sea Toll becomes one of the important concepts of sea transportation development for Indonesia which is an archipelago country or maritime country. The concept of the sea toll needs to be developed and implemented so that sea transportation becomes the backbone of Indonesia's integrated multi-modal transportation system. The port connectivity system is shown in Figure 13.

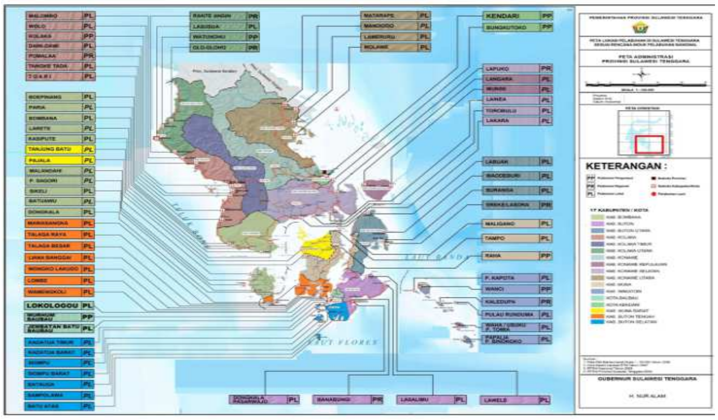

Figure 13: Port Connectivity

Based on Figure 13, Southeast Sulawesi has around 70 ports, consisting of:

- 5 (five) Collecting Ports which are: Murhum (Bau-Bau), Bungkutoko (Kendari), Kolaka, Raha, and Wanci.
- 5 (five) Feeder Portswhich are Pomalaa, Ereke, Lapuko, Banabungi (Pasar Wajo), and Pelabuhan Sikeli.
- 60 (sixty) Local Ports.
- 35 (thirty-five) Ferry Ports.

Existing ports do not have adequate facilities including large gathering place. In addition, the area of the harbor has not been sufficient, making entrepreneurs have lost enthusiast to use the ports in loading and unloading activities. Adequate and proper port infrastructure development will make people in the archipelago regions to be more interested in building businesses so they can employ many local laborers. The results of production are not only a commodity among regions of the archipelago, but it is also expected to be an export commodity.

CONCLUSIONS

It can be concluded from data analysis and results from that:

- Development of Malawi Port is required to increase the dock length to reach the depth so that the ship that does not operate or not directly lean before can be directly docked at the harbor.
- The system of inter-island connectivity has not been supported by supporting infrastructure so that port operational has not been effective and efficient for the loading and unloading of goods and passengers.

SUGGESTIONS

It can be suggested from this study that further research in this issue should be:

- Ship service and goods supporting system require port equipment and other supporting facilities at the port along with the activity of ship as loading and unloading of goods.
- Sea transportation is more efficient for transporting large quantities of goods along with proper speeds and relatively low cost so that they are very useful for transportation in archipelago states.

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